THE EFFECT OF TIME OF DAY ON YOUNGER ADULTS' SUBJECTIVE AGE

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

The Effect of Time of Day on Younger Adults' Subjective Age. (May 2015)

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Subjective age, or how old one feels, is associated with one's mental and physical well-being. Recent research suggests that subjective age may be malleable and can be affected by contextual variables. This proposed study aims to determine if subjective age is affected by time of day. Research shows that the time of day (the morning vs. afternoon) influences people's ability to perform cognitive tasks and alters their attitudes and judgments. We hypothesize that time of day may also influence how old people feel- their subjective age. If results show that subjective age is affected by time of day, then this will demonstrate the subjective age is malleable, and that people's self-perceptions can change throughout the day.

SECTION I

INTRODUCTION

Subjective age refers to how old an individual feels, as opposed to her true chronological age. In fact, people rarely report feeling they are their true chronological age. The general trend is that younger adults feel older than they are and older adults feel younger than they are. In a longitudinal study of the interaction between subjective age and chronological age, researchers found that subjective age trend flips at 25 years of age (Rubin & Bernsten, 2006). Prior to turning 25 most people report feeling older than their chronological age and after turning 25 most people report feeling younger than their chronological age (Hubley & Hultsch, 1994). In addition, the gap between subjective age and chronological age widens as people grow older.

These trends are important because subjective age has been shown to be a predictor of significant psychological and physical health outcomes. Younger subjective age is correlated with higher self-ratings of health (Hubley & Hultsch, 1994) and with greater aging satisfaction (Kotter-Grühn, Kleinspehn-Ammerlahn, Gerstorf, & Smith, 2009). In addition, subjective age predicts mortality. A 16 year-long longitudinal research study found that older adults whose subjective age increased four years after the baseline measure were more likely to die in the next 12 years than adults whose subject age remained the same (Kotter-Grühn, Kleinspehn-Ammerlahn, Gerstorf, & Smith, 2009). This finding suggests that subjective age could be a predictor of death.

While it has mostly been thought of as a stable construct, some researchers have been able to manipulate subjective age. For instance, older adult’s subjective age increases after participating in a memory experiment (Hughes, Geraci & De Forrest, 2013). Older adults were asked to report their subjective age then they participated in a standard memory experiment. After completing the memory test, participants were asked to report their subjective age a second time. Result's showed that older adult's subjective age increased after doing the memory test. In contrast, younger adult's subjective age was not affected by taking a memory test, and older adult's subjective age was not manipulated by taking a test that was not relevant to aging stereotypes (a vocabulary test). Thus older adults felt older when they were placed in a context (a memory test) that highlighted their age identity. Further research showed that merely expecting to participate in a memory experiment increased older adult's subjective age. Older adults reported their baseline subjective age and then the experimenter described the memory test they would be taking. Participants reported their subjective age for the second time after the description of the free recall memory test but before they had completed the test. Hughes et al., found that the expectation that they would be tested on their memory increased older adult's subjective age.

It's not hard to make older adults feel old. In one experiment older adult's subjective age was increased when they were asked to read hard-to-distinguish writing (Eibach, Mock & Courtney, 2010). In this study older adults were presented with a passage to read by an experimenter. The control group had a clearly printed passage to read, one experimental group had a blurry passage but were warned that it would be difficult to read due to a photocopying problem, and another experimental group were given the blurry passage to read but were given no explanation as to why it was blurry. The results showed that the experimental group that was given no explanation as to why the passage was blurry had the smallest discrepancy between chronological and subjective age, meaning that their subjective age was higher than the control group and the group given an explanation. Researchers theorize that this effect is due to older adults attributing the difficulty reading the passage to the loss of eyesight associated with age, making themselves feel older. This research demonstrates that older adult's subjective age can be manipulated by something as seemingly inconsequential as a poorly printed passage of writing.

Not everyone is out to get older adults however; some researchers are discovering ways to make older adults feel younger. In one instance, researchers attempted to lower subjective age and increase handgrip strength of older adults by downward social comparison (Stephan, Chalabaev, Kotter-Gruhn & Jaconelli, 2013). This was accomplished by making older adults think they are stronger than other adults their age. First researchers found participant's baseline subjective age and handgrip strength. After the baseline handgrip strength test the experimenter gave the participants in the experimental group positive feedback, saying that they had performed better on the handgrip test than 80% of people their age. This induced a downward social comparison, causing the participants to feel that they are stronger than their peers. A second measure of both subjective age and handgrip strength were taken after the positive feedback was given. The data showed the positive feedback both lowered the subjective age and increased handgrip strength in older adults. This research demonstrates that not only can subjective age can be manipulated by social cues, but that these mental processes have a physical affect- increased strength!

As you can see a broad range of constructs can manipulate a person's subjective age. The present research examined whether another simple contextual cue, time of day, affects people's subjective age. Though it seems innocuous, time of day has been demonstrated to have significant effects on human cognition (see Schmidt, 2007).

Cognitive functioning operates on a circadian rhythm that determines waking and sleeping (Borbély, 1982). This circadian rhythm is the result of two processes interacting: the homeostatic process and the circadian timing process. The homeostatic process (also called sleep pressure) is the sleep-promoting process, the need to sleep that builds up the longer one has been awake. As it builds throughout the day we see a decrease in alertness and an increase of fatigue. At night during non-REM, slow-wave sleep this sleep pressure lessons so that upon waking one is refreshed. The second process is called the circadian timing process (also called circadian pacemaker). This is the internal clock that flips between promoting wakefulness and promoting sleepiness. Unlike the homeostatic process, it is independent of how long a person being awake or asleep. Instead, the circadian timing process is an internal process regulated by the suprachiasmatic nuclei, located in the anterior hypothalamus. The troughs and peaks of sleepiness and wakefulness can be indirectly measured by taking one's core body temperature, which oscillates with circadian timing process. These two processes, the homeostatic process and circadian timing process, interact to ensure consolidated periods of sleeping and waking. For instance, in the early evening when the homeostatic process is calling for sleep the circadian timing process keeps us awake. In the morning when sleep pressure has been reduced circadian timing process also keeps us from waking up super early (Schmidt, 2007).

Differences in performance on cognitive tasks during different parts of the day may be explained by the increase in homeostatic sleep pressure, the independent, internal circadian timing process promoting wakefulness or sleepiness, or an interaction between the two (Carrier & Monk, 2000). The internal circadian timing process differs from person to person, and because of this there are different times of day that people peak in their mental functioning. "Morning-types" have their peak time of day in the morning, and “Evening-types” in the afternoon or evening. Peak time of day also varies with age, with younger adults tending to be evening types and older adults tending to be morning types (Horne & Ostberg, 1976). This shift towards eveningness may be due to a weaker transduction of the circadian timing process downstream of the circadian timing system as adults age (Monk & Kupfer, 2000).

The reason why circadian rhythm affects cognitive performance is still debated. The leading theory is that circadian rhythm influences attention capacity (Horowitz, Cade, Wolfe, & Czeisler, 2003). Attention is one’s ability to focus on processing specific information, selecting and attending to the object at hand while inhibiting thoughts about off-topic things. Sustained attention is necessary to do well in almost all cognitive tests. In addition, attention is moderated by time of day, making it an excellent candidate in explaining time of day effects (Cajochen, Khalsa, Wyatt, Czisler, & Dijk, 1999).

When success on a task is influenced by whether a person was tested in their peak or off-peak time of day we have what is called a synchrony effect. Should we discover a synchrony effect on subjective age, it could change how subjective age research progresses. Synchrony effects are far from rare. They have been found in a broad range of cognitive tasks. For example, people tend to be more distracted at their off peak time of day (May, 1999). In one study, participants were asked to complete a test of creativity, where they are presented with three cue words (like ship, outer, and crawl) and asked to come up with the target word that is associated with all of them (in this case, space). Participants tested in peak and off-peak time of day showed no difference in performance on this task alone. However, when distracting words are added to the list, which participants were instructed to ignore, then participants tested in their peak time of day did significantly better than those tested in their off peak time of day. This demonstrates that there is a synchrony effect on attention- and being tested during off-peak time of day lowers one's ability to inhibit distractors.

Time of day has also been found to affect memory performance (Lehmann, Marks & Hanstock, 2013). The Rey Auditory Verbal Learning Test (RAVLT) is a test of short term memory that is used clinically to help distinguish normal memory decline in older adults from pathological memory decline. Researchers administered the RAVLT to older and younger adults during their peak or off-peak times of day. Both younger and older adults performed better on the RAVLT during their peak time of day, though the effect was more pronounced in older adults. This finding suggests that short term memory is affected by time of day and that older adults may be more susceptible to time of day effects.

There may not be time of day effects for all kinds of memory, however. There is a lot of evidence to support that time of day has an effect on explicit memory- memory of facts and experiences (Hash, Chung, May, & Foong, 2002; Yoon, 1997; Yang, Hasher, & Wilson 2007). However the jury's still out on implicit memory-memory of automatic processes such as tying shoes or riding a bike. Very little research has been done on time of day's effect on implicit memory. May's aforementioned study found a reverse synchrony effect on implicit memory; participants performed better on automatic processes during off-peak times of day compared to peak times of day (May, 1999). This has the interesting implication that it would be better to do certain automatic tasks during one's off-peak time of day rather than peak time of day. However the follow up research done so far has not found a significant interaction between time of day and automatic processes, so it is unclear whether an interaction actually exists (Yang, Hasher, & Wilson, 2007).

In addition to influencing attention and memory, time of day also influences self-regulation. Self-regulation is one's ability to behave in a way consistent with values and self-interest. Self-regulation is why people don't blurt out the first thing that pops in their head, grab the last soda out of a friend's fridge, or curse in front of their boss. Several studies have shown that self-regulation is highest during peak times of day, and that behavior that goes against values is more likely to be exhibited in off-peak times of day. For instance, recent research shows that people tend to be less moral in the afternoon relative to the morning (Kouchaki & Smith, 2014). Undergraduates participated in the study in either the morning (8am-10am) or in the late afternoon (3pm-5pm). In the lab students were given an opportunity to lie on a perception test to earn more money. They were shown several pictures of a group of dots with a line through the middle. They were asked to report whether there were more dots on the right or the left side of the line. Participants were told they would receive five cents for responding that there are more dots on the right side of the line and 50 cents for responding that there are more dots of the left side. This gave the participants an incentive to lie about how many dots were on each side of the line, as they would receive more money for reporting there were more dots on the left. The researchers found that participants indicated that there were more dots on the left side of the line more frequently in the afternoon than participants in the morning. That is, they were more willing to lie in the afternoon than in the morning. This suggests that time of day has an effect on potentially important behavior.

Not only are people more willing to lie during their off-peak time of day, they are more reliant on stereotypes when judging other people (Bodenhausen, 1990). Researchers found that college students were more likely to rely on stereotypes when making judgments about their peers when tested in their non-optimal times of day. Undergraduates were asked to read different stories about student misconduct and answer several questions about the motives of those students, including how guilty they feel about their crimes. Results showed that, during their off-peak time, of day participants rated stereotyped student criminals (such as athletes cheating on a test or African American students selling drugs) to feel more guilty compared to non-stereotyped student criminals. This shows a greater reliance on stereotypes to make character judgments during off-peak times of day demonstrating lowered self-regulation and less moral behavior.

Thus, time of day influences genitive behavior. We hypothesize that it may also influence self-perceptions and in particular subjective age. How time of day interacts with subjective age is of particular interest because of the important health outcomes that subjective age predicts in older adults. We hypothesize that older adults will feel younger during their peak time of day compared to their off-peak time of day. With younger adults the effect time of day may have on subjective age is more ambiguous. Because younger adults generally have a higher subjective age than chronological age, it is possible that testing at their peak time of day will intensify this effect. In the case we predict younger adult's subjective age will be higher at peak time of day compared to off peak time of day. However it could also be the case that younger adults, like older adults, feel younger at their peak time of day because human cognition is sharper at peak time of day; making them feel younger.

SECTION II

METHODS

Participants

Fifty-seven undergraduate students (23 males and 34 females) at Texas A&M University (*M* age = 18.90, *SD* = .83) participated in this study in exchange for course credit. Participants were mostly first-year students (*M* education = 12.30; *SD* = .57) and had vocabulary scores, that assessed crystalized intelligence, that are average for this population (*M* vocabulary = 28.34; *SD* = 3.17).

Design

The study used a between-subjects design, with one group of participants assigned to be tested in the morning (8:00 am to 9:00 am) and one group of participants assigned to be tested in the afternoon (3:00 pm to 4:00 pm). Morning and evening were matched on age (t (56) < 1), education (t (55) 1.21, p < .05), and vocabulary (t (56) < 1).

Measures

Subjective Age Questionnaire

The subjective age questionnaire simply asks participants about different facets of their subjective age, and was developed in use for this study. Participants were asked to indicate how old they feel by drawing a tick on a 120 mm line, where the start of the line represents zero years old and the end of the line represents 120 years old. Thus the distance of the tick from the zero year mark indicated the participant's subjective age, where one millimeter is equal to one year.

Prior research on subjective age has recorded subjective age in this manner to prevent participants from remembering and repeating the same number when subjective age was recorded multiple times (Hughes, 2013). In addition to just asking about general subjective age, this questionnaire also asks about other aspects of subjective age. It asks participant's to indicate how old they feel in terms of personal well-being (emotionally, socially, quality of life, maturity-wise), how old they feel physically, and how old they feel cognitively (memory, concentration, mental sharpness).

OSPAN- Operation Span Test

The OSPAN is a measure of working memory that correlates highly with other measures of working memory and has high test-retest reliability (Engle, Nations, & Cantor, 1990). Participants are asked to answer 'true' or 'false' a series of simple equations presented on a computer (such as 6/2-3= 0) by typing 't' for true and 'f' for false. After each equation a letter appears that participants are instructed to try to remember. After several equations participants are cued to recall as many as the letters as possible in the order that they were presented. Traditionally this is done orally, but in this lab we opted to have participants write the letters they remembered on a sheet of paper so the task could be completed without interacting with the experimenter. This test will be given to see if we obtain the expected time of day effect on memory performance.

Free Recall Test

Participants are given two minutes to study 30 nouns and instructed to try to remember as many of the words as possible. Immediately following the study period they are given 3 minutes to recall and record the nouns in any order on a blank sheet of paper.

MEQ- Morning-Eveningness Questionnaire

The MEQ measures sleep-wake behaviors on a scale of 16 to 86, with higher scores indicating greater preference for the morning and lower scores indicating greater preference for the evening (Horne & Ostberg, 1976). The MEQ has been found to correlate with changes in alertness, body temperature, and sleep/wake habits (Tankova, Adan, & Buela-Casal, 1994).

Stanford Sleepiness Scale

The Stanford Sleepiness Scale is an alertness measure that ranges from 1, “Feeling active, vital, alert, or wide awake” to seven, “No longer fighting sleep, sleep onset soon; having dream-like thoughts”. Participants are simply asked to read the description of each level of sleepiness then write down the number that best correlates with how they are feeling at that moment. This measure correlates with performance on mental tasks as well as the amount of sleep people individuals are currently running on (Hoddes, Zarcone, Smythe, Phillips, & Dement, 1973).

Vocabulary Test

The Shipley Institute of Living- Revised vocabulary scale is a measure of crystalized intelligence (Shipley, Gruber, Martin, & Klein, 2009). This vocabulary test correlates with other intelligence measures such as the WAIS (Villar, 2005). It is included to insure that we do not have significant differences in intelligence between groups that would explain differences in the data.

Procedures

Participants came into the lab during either a morning block (8am-10am) or afternoon block (3pm-5pm) and were run individually. After providing consent to participate, they completed a series of cognitive tests, followed by two questionnaires, the MEQ and Stanford Sleepiness Scale. Lastly, they completed a vocabulary test. Following these procedures participants were debriefed, given a handout explaining the experiment, and asked if they have any questions.

SECTION III

RESULTS

As expected, younger adults mostly self-identified as being evening types. Fifty-seven out of 77 participants were classified as evening types based on their MEQ scores and self-identification. Only those participants who identified as being evening types (57) were included in the analyses to examine the effect of time of day on typical (evening-type) younger adults. Next we examined the effect of time of day on subjective age and on cognition. A between subjects t-test revealed that overall subjective age was not affected by time of day, (*M* afternoon subjective age =24.42 ; *M* morning subjective age =23.44), t (1, 55) < 1. Interestingly, time of day influenced some of the specific types of subjective age (see Figure 1). For example, younger adults had a higher emotional subjective during their peak time of day compared to their off-peak (*M* morning subjective age=23.3; *M* afternoon subjective age=30.36), t(1,56)=-2.27, and that younger adults have higher cognitive subjective age during their peak time of day compared to their off-peak time of day (*M* morning subjective age= 24.72; *M* afternoon subjective age=28.15), t(1,56)=-1.02. However a t-test also showed that young adults had a lower physical subjective age during their peak-time of day compared to their off-peak (*M* morning subjective age= 29.08; *M* afternoon subjective age=24.91), t(1,56)=1.12 though results were not quite significant.

A time of day effect was also found in the OSPAN test, participants performed significantly better during their peak time of day compared to their off peak (*M* morning OSPAN=29.64; *M* afternoon OSPAN=36.16), t(1,55)= -1.39, again results were just shy of significant. There were no differences in sleepiness, ($t(56) < 1$), suggesting that the effects of time of day on subjective age and cognition were not due simply to feelings of sleepiness.

SECTION IV

DISCUSSION

Subjective age has generally been thought of as a stable trait. However recent research has begun to demonstrate that subjective age could be malleable. Older adult's subjective age was increased when they were asked to read hard to distinguish writing (Eibach et al., 2010). Older adult's subjective age was decreased when they were told they performed better than their same age peers on a test of strength (Stephan et al., 2013) or even when they were given a memory test (Hughes et al., 2013 These different contexts caused significant changes in an individual's subjective age. We were interested in whether the context of time of day would also effect subjective age.

Time of day has been demonstrated to affect various cognitive functions. For instance people are more susceptible to distraction during their off-peak time of day (May, 1999) and people perform better on working memory tasks during their peak time of day (Lehmann et al., 2013). Time of day also effects self-regulation. For example, one study found that people were less likely to cheat in the morning than in the afternoon (Kouchaki & Smith, 2014) and people were more reliant on stereotypes when making character judgements during their off-peak time of day (Boudenhausen, 1990). These results led us to think that time of day may effect subjective age in a similar way. This study was designed to test whether time of day effects younger adults' subjective age.

We only looked at the data from young adults who identified as being evening-types, which is typical for a young adult (Horne & Ostberg, 1976). As evening types, the subjects of this study have their peak time of day is in the afternoon/evening and their off-peak time of day in the morning. Our results showed that the participants felt significantly older emotionally and trended towards feeling older cognitively during their peak time of day (the afternoon) compared to their off-peak time of day (the morning). The opposite was true for physical subjective age. Participants felt physically younger during their peak time of day (the afternoon) and physically older during their off-peak time of day (the morning). Though these results support our hypothesis that time of day has an effect on subjective age, they also open up a host of new questions.

What does it mean to feel cognitively older? Physically older? Emotionally older? Although we can't answer these questions with the current study, we can speculate that these subsets of subjective age reflect young adult's positive associations with aging. We favor the interpretation that cognitive subjective age reflects how old the individual feels in terms of mental sharpness, general knowledge, concentration, and memory. The fact that younger adults feel older cognitively during their peak time of day could reflect that they feel more confident during their peak time of day, and identify as being older cognitively because stereotypically being older means being smarter. Likewise we believe that emotional subjective age reflects how mature individuals feel. The younger adults in this study felt emotionally older in the afternoon compared to the morning, which suggests that they feel more mature during their peak time of day. Again this pattern of data could indicate that younger adults have a positive association with being older and being more mature. The results might be different in an older population who might associate feeling older with more negative issues, including dementia or other forms of cognitive decline. Physical subjective age, however, trended in the opposite direction, with young adults feeling younger during their peak time of day rather than older. This leads us to speculate that younger adults have positive associations with being younger rather than older when it comes to physicality. Future research using a greater number of participants and both older and younger adults will allow us to investigate these implications further.

For now, the results suggest that time of day affects certain aspects of subjective age. These results are also the first to show that younger adult's subjective age is malleable, and can be influenced by time of day. This finding adds to the literature that shows the dramatic effect of time of day on attitudes, behavior, and now self-perception.

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APPENDIX

Figure 1. Differences in subsets of subjective age